

UNIVERSITY OF HAWAII

Water Resources Research Center  
Office of the Director

MEMORANDUM

July 19, 1973

TO: Henri Minette, Deputy Director  
Environmental Health Program  
Department of Health

VIA: Doak C. Cox, Director  
Environmental Center

*Doak C. Cox*

FROM: Henry Gee, WRRC

*H.G.*

Proposed Phosphorus Standards for Fresh Water Streams  
in Hawaii

The 2 July 1973 revised draft of amendments proposed by the Department of Health to the Water Quality Standards, Public Health Regulations Chapter 37-A, contains a proposed standard of 0.050 mg/l for total phosphorus in waters of classes 1 and 2, the waters of streams, lakes and reservoirs (subsec. 6.B.3, p. 21). They also contain a proposed requirement that the natural ratio of nitrate-nitrogen to phosphate-phosphorus be maintained in waters of the same classes. Neither of these proposed standards is suitable for fresh surface waters in Hawaii.

Phosphorus concentration

The proposed numerical standard for the concentration of total phosphorus appears to be based on guidelines issued by the Environmental Protection Agency (Guidelines for Developing or Revising Water Quality Standards, 1973). However, it is inappropriate for Hawaiian streams generally because (1) it is exceeded in nature, and (2) the usual concerns with high nutrient levels are generally inapplicable in Hawaii. The EPA guidelines actually suggest two significant levels of total phosphorus in fresh waters: 0.050 mg/l to prevent eutrophication in lakes and 0.100 mg/l to prevent nuisance plant growth in streams. However, no Hawaiian streams enter lakes, and although the low-water flows of many are directed into reservoirs, the flood flows of all and the low water flows of many directly reach coastal waters, in which, for the most part, dispersal is very effective. Hawaiian streams are characteristically steep and fast flowing, particularly during wet weather when phosphorus concentrations are highest, and plants cause very little nuisance because of limited growth due to the high velocity flow.

Ching (1972) studied the water quality of Manoa Stream which drains a basin of 4200 acres consisting of forested and residential areas with very light commercial activities. During dry weather conditions, the mean phosphorus concentration of 5 sampling stations was 0.101 mg/l with a range of 0.072 to 0.134 mg/l. Under wet weather conditions, the mean concentration increased to 0.196 mg/l with values ranging from 0.175 to 0.204 mg/l. These values are 3 to 4 times higher than the suggested standard of 0.059 mg/l.

Kalihi Stream drains a basin of 6.7 square miles consisting of forest reserve watershed, residential and commercial and light industrial area. During 1970 and 1971 a study by consortium consisting of Engineering Science, Inc., Sunn, Low, Tom and Hara, Inc. and Dillingham Environmental Co. (1972), working on the Oahu Water Quality Program for the City and County of Honolulu, found the total phosphorus to range from 0.022 to 0.030 mg/l. A more recent study by Matsushita (1973) found the mean total phosphorus concentration during dry weather flow to be 0.18 mg/l with a range of 0.11 to 0.34 mg/l and during wet weather the mean to be 0.26 mg/l with a range of 0.03 to 0.27 mg/l. From a subbasin of an undeveloped area of 354 acres, the dry weather flow was found to have concentrations of 0.11 mg/l in the stream.

A water quality study of Kaneohe Basin streams by Young (1969) at eleven sampling stations showed maximum phosphorus concentration occurred during the rainy winter months of December and January with a mean value of 0.267 mg/l and a range of 0.096 to 0.724 mg/l as P. A total of 9 streams were studied in this survey.

Four streams entering Pearl Harbor were studied by the Water Resources Research Center (Tenorio, Young, and Whitehead 1969). Samples were taken over a 3-year period and the following mean concentrations of  $\text{PO}_4\text{-P}$  were found:

Waiawa Stream = 0.598 mg/l; Waialeale Stream = 0.345 mg/l; Waimalu Stream = 0.043 mg/l and Kalanianaʻʻohi Stream = 0.095 mg/l.

Thus fresh water streams should be exempted from the EPA criteria because of two factors listed in a memo to regional administrators regarding phosphorus in the guidelines (April 1973): (1) The streams of Hawaii contain naturally occurring phosphorus exceeding the 100  $\mu\text{g/l}$  limit, (2) The steep banks, high velocity flows, and high and natural concentrations of silt constitute a natural conditions in Hawaiian streams limiting plant growth nuisances.

The atomic ratio of  $\text{NO}_3\text{-N}$  to  $\text{PO}_4\text{-P}$  in natural streams can be a fairly constant value or it can vary from one to two orders of magnitude. The variations may result from change in biological uptake, which in turn is dependent upon temperature, amount of solar radiation, stream flow, and turbidity. They may also result from changes in phosphorus concentration

associated with changes in physical-chemical factors such as alkalinity, hardness, pH, and sediment concentration. The following tables show that the ratio varies greatly not only in four streams that discharge into Pearl Harbor but also in Kahana Stream which drains an undeveloped area on windward Oahu.

(Data from Tenorio, et al., 1969)

(QCW Project Data, unpublished)

NO <sub>3</sub> -N:PO <sub>4</sub> -P RATIO					N:P RATIO	
DATE	WAIAWA	WAIKELE	KALAUAO	WAIMALU	DATE	KAHANA
08/17/67	1.74	4.32	0	0	05/14/72	1.96
10/03/67	1.44	3.62	23.10	1.33	07/17/72	8.41
11/21/67	2.27	2.60	2.13	12.23	10/31/72	2.00
11/26/67	9.74	3.77	13.86	8.26	12/20/72	2.28
02/20/67	1.88	0.64	16.17	9.53	01/17/73	9.97
04/04/68	2.28	2.70	0	0	02/28/73	76.0
06/27/68	2.63	2.87	17.01	0	04/24/73	4.62
08/27/68	2.33	3.40	20.38	24.25	06/20/73	0.73
11/04/68	4.04	4.16	23.26	97.02		
01/31/69	0.48	3.15	0	4.62		
03/13/67	1.90	2.25	3.53	0.19		

The variation in the ratio even in natural conditions confirms the absurdity, already pointed out by the Environmental Center (Cox, 1973), of allowing no change in the ratio of NO<sub>3</sub>-N to PO<sub>4</sub>-P from natural conditions. It also indicates that no absolute ratio can be set as a standard.

Tenorio, P. A., Young, R. F., and Whitehead, H. C. 1969. "Identification of Return Irrigation Water in the Subsurface: Water Quality". Water Resources Research Center, University of Hawaii, Technical Report No. 33.

## REFERENCES

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3. Engineering Science, Inc., Sunn, Low, Tom and Hara, Inc., and Dillingham Environmental Co. "Water Quality Program for Oahu with Special Emphasis on Waste Disposal," Final Report, Summary, February 1972.
4. Environmental Protection Agency, Water Planning Division, 1973. "Guidelines for Developing or Revising Water Quality Standards under the Federal Water Pollution Control Act Amendments of 1972".
5. Environmental Protection Agency. Memo to Regional Administrators "Phosphorus Water Quality Guidelines for Developing or Revising Water Quality Standards", April 1973.
6. Matsushita, G. K. "The Effects of Urban Runoff on the Water Quality of Kalihi Stream," A thesis for the Master of Science Degree in Civil Engineering, University of Hawaii, May 1973.
7. Tenorio, P. A., Young, R. F., and Whitehead, H. C. 1969. "Identification of Return Irrigation Water in the Subsurface: Water Quality". Water Resources Research Center, University of Hawaii, Technical Report No. 33.
8. Young, R. H. F., Morphew, K. L., and Burbank Jr., N. C. Water Quality Study--Estuarine Pollution in the State of Hawaii Part II: Kaneohe Bay Study.